CLAIMS

1. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate;

a first surface acoustic wave filter section including first to third IDTs arranged along a surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal, and the first and third IDTs on both the sides or the second IDT in the center being connected to the first balanced terminal; and

a second surface acoustic wave filter section including first to third IDTs arranged in the surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal, the first and third IDTs on both the sides or the second IDT in the center being connected to the second balanced terminal, and the second surface acoustic wave filter section being constructed to have a phase of an output signal to an input signal different by 180 degrees with respect to the first surface acoustic wave filter section, the balanced-type surface acoustic wave filter being characterized in that:

in the first and second surface acoustic wave filter sections, in a pair of IDTs adjacent to each other with a gap interposed therebetween in the surface acoustic wave propagating direction, a section where a cycle of a part of electrode fingers including an electrode finger facing the gap is smaller than a cycle of electrode fingers of a main part of the IDT is set as a narrow pitch electrode finger section; and

that when an electrode finger pitch of the narrow pitch electrode

finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the IDT connected to the balanced terminal is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as K1, and the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the IDT connected to the balanced terminal is set as K2, the following relations:

$P1>P2$; and

$1.12 \leq K1/K2 \leq 1.65$

are satisfied.

2. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate;

a first surface acoustic wave filter section including first to third IDTs arranged along a surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal and the first and third IDTs on both the sides or the second IDT in the center being connected to the first balance terminal; and

a second surface acoustic wave filter section including first to third IDTs arranged in the surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal, the first and third IDTs on both the sides or the second IDT in the center being connected to the second balanced

terminal, and the second surface acoustic wave filter section being constructed to have a phase of an output signal to an input signal different by 180 degrees with respect to the first surface acoustic wave filter section, the balanced-type surface acoustic wave filter being characterized in that: in the first and second surface acoustic wave filter sections, in a pair of IDTs adjacent to each other with a gap interposed therebetween in the surface acoustic wave propagating direction, a section where a cycle of a part of electrode fingers including an electrode finger facing the gap is smaller than a cycle of electrode fingers of a main part of the IDT is set as a narrow pitch electrode finger section; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the IDT connected to the balanced terminal is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as K1, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the IDT connected to the balanced terminal is set as K2, the number of electrode fingers of the narrow pitch electrode finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as K1n, and the number of electrode fingers of the narrow pitch electrode finger section of the IDT connected to the balanced terminal is set as K2n, the following relations:

$P1>P2$;

$K1n=K2n$; and

$1.12\leq K1/K2\leq 1.65$

are satisfied.

3. The balanced-type surface acoustic wave filters according to Claim 1 or 2, wherein when a metallization ratio in the first and second surface acoustic wave filter sections is set as d and an electrode finger cross width is set as W, $67.4\ \lambda I \leq W/d \leq 74.3\ \lambda I$ (where λI denotes a wavelength of the IDT) is satisfied.

4. A balanced-type surface acoustic wave filter connected to a balanced terminal and first and second unbalanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the second IDT is connected to the unbalanced terminal and the first and third IDTs on both the sides are respectively connected to the first and second balanced terminals;

that in an area where the first to third IDTs are adjacent one another, the respective IDTs have narrow pitch electrode finger sections and an electrode finger pitch of the narrow pitch electrode finger section is set smaller than an electrode finger pitch of a main part of the pitch electrode finger section of the IDT provided with narrow pitch electrode fingers;

that a phase of the first IDT is reversed by 180 degrees with respect to a phase of the third IDT; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the second IDT located in the center is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the second IDT is set as K1, and the number of electrode fingers of the pitch electrode finger section

except for the narrow pitch electrode finger section of the first and third IDTs is set as K2, the following relations:

P1>P2; and

1.12≤K1/K2≤1.65

are satisfied.

5. A balanced-type surface acoustic wave filter connected to a balanced terminal and first and second unbalanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the second IDT is connected to the unbalanced terminal and the first and third IDTs on both the sides are respectively connected to the first and second balanced terminals;

that in an area where the first to third IDTs are adjacent one another, the respective IDTs have narrow pitch electrode finger sections and an electrode finger pitch of the narrow pitch electrode finger section is set smaller than an electrode finger pitch of a main part of the pitch electrode finger section of the IDT provided with narrow pitch electrode fingers;

that a phase of the first IDT is reversed by 180 degrees with respect to a phase of the third IDT; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the second IDT located in the center is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the second IDT is set as K1, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the first and

third IDTs is set as K2, the number of electrode fingers of the narrow pitch electrode finger section of the second IDT is set as K1n, the number of electrode fingers of the narrow pitch electrode finger section of the first and third IDTs is set as K2n, the following relations:

P1>P2;

K1n=K2n; and

$1.12 \leq K1/K2 \leq 1.65$

are satisfied.

6. The balanced-type surface acoustic wave filters according to Claim 4 or 5, wherein when a metallization ratio in the first to third IDTs is set as d and an electrode finger cross width is set as W, $134.8\ \lambda I \leq W/d \leq 148.6\ \lambda I$ (where λI denotes a wavelength of the IDT) is satisfied.

7. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the first and third IDTs located on both the sides of the surface acoustic wave propagating direction are connected to the unbalanced terminal;

that the second IDT includes first and second IDT sections divided in the surface acoustic wave propagating direction, the first and second IDT sections are respectively electrically connected to the first and second balanced signal terminals, and the first to third IDTs are constructed to set a phase of a signal emanating from the unbalanced terminal to the first balanced signal terminal reversed by 180 degrees with respect to a phase of a signal emanating from the

unbalanced terminal to the second balanced signal terminal;

that in an area where the first to third IDTs are adjacent one another in the surface acoustic wave propagating direction with a gap interposed therebetween, a plurality of electrode fingers near the gap correspond to a narrow pitch electrode finger section where a pitch of the electrode fingers is relatively small; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs connected to the unbalanced signal terminal is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the second IDT whose first and second IDT sections are respectively connected to the first and second balanced signal terminal is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the first and third IDTs is set as K1, and the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the second IDT is set as K2, the following relations:

$P1>P2$; and

$1.12\leq K1/K2\leq 1.65$

are satisfied.

8. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the first and third IDTs located on both the sides of the surface acoustic wave propagating direction are connected to the unbalanced terminal;

that the second IDT includes first and second IDT sections divided

in the surface acoustic wave propagating direction, the first and second IDT sections are respectively electrically connected to the first and second balanced signal terminals, and the first to third IDTs are constructed to set a phase of a signal emanating from the unbalanced terminal to the first balanced signal terminal reversed by 180 degrees with respect to a phase of a signal emanating from the unbalanced terminal to the second balanced signal terminal; and

that in an area where the first to third IDTs are adjacent one another in the surface acoustic wave propagating direction with a gap interposed therebetween, a plurality of electrode fingers near the gap correspond to a narrow pitch electrode finger section where a pitch of the electrode fingers is relatively small, and when an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs connected to the unbalanced signal terminal is set as P1, an electrode finger pitch of the narrow pitch electrode finger section of the second IDT whose first and second IDT sections are respectively connected to the first and second balanced signal terminal is set as P2, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the first and third IDTs is set as K1, the number of electrode fingers of the pitch electrode finger section except for the narrow pitch electrode finger section of the second IDT is set as K2, the number of electrode fingers of the narrow pitch electrode finger section of the first and third IDTs is set as K1n, and the number of electrode fingers of the narrow pitch electrode finger section of the second IDT is set as K2n, the following relations:

$P1>P2$;

$K1n=K2n$; and

$1.12\leq K1/K2\leq 1.65$

are satisfied.

9. The balanced-type surface acoustic wave filters according to

Claim 7 or 8, wherein when a metallization in the first to third IDTs is set as d and an electrode finger cross width is set as W, 134.8 $\lambda I \leq W/d \leq 148.6\ \lambda I$ (where λI denotes a wavelength of the IDT) is satisfied.

10. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate;

a first surface acoustic wave filter section including first to third IDTs arranged along a surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal, and the first and third IDTs on both the sides or the second IDT in the center being connected to the first balanced terminal; and

a second surface acoustic wave filter section including first to third IDTs arranged in the surface acoustic wave propagating direction on the piezoelectric substrate, the second IDT in the center or the first and third IDTs on both the sides being connected to the unbalanced terminal, the first and third IDTs on both the sides or the second IDT in the center being connected to the second balanced terminal, and the second surface acoustic wave filter section being constructed to have a phase of an output signal to an input signal different by 180 degrees with respect to the first surface acoustic wave filter section, the balanced-type surface acoustic wave filter being characterized in that:

in the first and second surface acoustic wave filter sections, in a pair of IDTs adjacent to each other with a gap interposed therebetween in the surface acoustic wave propagating direction, a section where a cycle of a part of electrode fingers including an electrode finger facing the gap is smaller than a cycle of electrode fingers of a main part of the IDT is set as a narrow pitch electrode

finger section; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the IDT connected to the unbalanced terminal of the first and second surface acoustic wave filter sections is set as P1, the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N1, an electrode finger pitch of the narrow pitch electrode finger section of the IDT connected to the first and second balanced terminals is set as P2, and the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N2, the following relations:

$P1 \neq P2$; and

$N1 < N2$

are satisfied.

11. The balanced-type surface acoustic wave filter according to Claim 10, characterized in that $P1 < P2$ is satisfied.

12. A balanced-type surface acoustic wave filter connected to a balanced terminal and first and second unbalanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the second IDT is connected to the unbalanced terminal and the first and third IDTs are respectively connected to the first and second balanced terminals;

that in an area where the first to third IDTs are adjacent one another, the respective IDTs have narrow pitch electrode finger sections and an electrode finger pitch of the narrow pitch electrode finger section is set smaller than an electrode finger pitch of a main part of the pitch electrode finger section of the IDT provided with narrow pitch electrode fingers;

that a phase of the first IDT is reversed by 180 degrees with respect to a phase of the third IDT; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the second IDT connected to the unbalanced terminal is set as P1, the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N1, an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs connected to the first and second balanced terminals is set as P2, and the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N2, the following relations:

$P1 \neq P2$; and

$N1 < N2$

are satisfied.

13. The balanced-type surface acoustic wave filter according to Claim 12, characterized in that $P1 < P2$ is satisfied.

14. A balanced-type surface acoustic wave filter connected to an unbalanced terminal and first and second balanced terminals and provided with a balance-unbalance conversion function, comprising:

a piezoelectric substrate; and

first to third IDTs arranged in a surface acoustic wave propagating direction on the piezoelectric substrate, the balanced-type surface acoustic wave filter being characterized in that:

the first and third IDTs located on both the sides of the surface acoustic wave propagating direction are connected to the unbalanced terminal;

that the second IDT includes first and second IDT sections divided in the surface acoustic wave propagating direction, the first and second IDT sections are respectively electrically connected to the first and second balanced signal terminals, and the first to third IDTs are constructed to set a phase of a signal emanating from the

unbalanced terminal to the first balanced signal terminal reversed by 180 degrees with respect to a phase of a signal emanating from the unbalanced terminal to the second balanced signal terminal;

that in an area where the first to third IDTs are adjacent one another in the surface acoustic wave propagating direction with a gap interposed therebetween, the respective IDTs have narrow pitch electrode finger sections at areas near the gap; and

that when an electrode finger pitch of the narrow pitch electrode finger section of the first and third IDTs connected to the unbalanced signal terminal is set as P1, the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N1, an electrode finger pitch of the narrow pitch electrode finger section of the second IDT whose first and second IDT sections are respectively connected to the first and second balanced signal terminal is set as P2, and the number of electrode fingers of the narrow pitch electrode finger section thereof is set as N2, the following relations:

$P1 \neq P2$; and

$N1 < N2$

are satisfied.

15. The balanced-type surface acoustic wave filter according to Claim 14, characterized in that $P1 < P2$ is satisfied.